

PATENT APPLICATION

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re the Application of:

Yasuhiko SAKAKI

Application No.: Not Yet Assigned

Filed: March 5, 2005

Attorney Dkt. No.: 108384-09010

For: CUP-TYPE PLATING APPARATUS

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Date: March 5, 2002

Sir:

Prior to examination of the above-identified patent application, please amend the application as follows:

IN THE SPECIFICATION:

Please amend the specification as follows:

Please replace the paragraph on page 2, lines 15-23 with the following new paragraph:

--Incidentally, the diaphragm to be used in this case is required to have an area roughly corresponding to the cross sectional area of the plating tank for the purpose of separating the anode and the wafer from each other. However, it is considerably difficult to put diaphragms to practical use, though there are many advantages, as there are technical difficulties in the production of diaphragms with large area as the

production cost of these diaphragms with increased area increases with respect to increases in geometrical ratio.--

Please replace the paragraph extending from page 2, line 24 to page 3, line 8, with the following new paragraph:

--The cup type plating apparatus having a diaphragm is often formed by separating a wafer side separate chamber above the diaphragm and an anode side separate chamber below the diaphragm, both separate chambers being provided with circulation tubes for charging and discharging the plating solution so that plating solution of each separate chamber can be circulated. Here in this specification, the route for charging the plating solution into and discharging it from the cathode side separate chamber is defined as the main plating solution circulation route, and the route for charging the plating solution into and discharging it from the anode side separate chamber is defined as the auxiliary plating solution circulation route.--

Please replace the paragraph on page 3, lines 9-17, with the following new paragraph:

--The purpose of providing such separate plating solution circulation routes is to prevent impurities, such as those formed from black films formed on and removed from the anode or formed in the plating solution by decomposition of additives, from getting into the plating solution to be charged into the wafer side separate chamber. Therefore, a cup type plating apparatus provided with a diaphragm can significantly reduce defective plating in plating of wafers where uniform and accurate plating quality are required.--

Please replace the paragraph extending from page 3, line 18, to page 4, line 7, with the following new paragraph:

--However, plating using this cup type plating apparatus with a diaphragm may cause such undesirable situations as follows. For example, in case of plating wafers with Cu using a cupric sulfate plating solution and a soluble Cu anode, Cu concentration of the plating solution in the anode side separate chamber increases, causing imbalance of Cu concentration between plating solutions in the wafer side and the anode side of separate chambers. Although a small amount of the plating solution of the anode side separate chamber infiltrates into the cathode side separate chamber forced by the osmotic pressure, increase of Cu concentration through dissolution of the Cu anode material proceeds much faster, resulting in significant difference in Cu concentration between the anode and the cathode side separate chambers. Once this phenomenon occurs, plating current efficiency is reduced accompanied by change in quality of plating, also causing the problem that stable plating becomes impossible.--

Please replace the paragraph on page 4, line 25, to page 5, line 2, with the following new paragraph:

--Accompanying the current progress of fine wiring processing technology, very fine processing has become available for circuit patterns provided on the surface of wafers, and technologies of more homogeneous plating has become required for wafer surfaces provided with such fine wiring processing as the target surfaces of plating.--

Please replace the paragraph on page 5, lines 3-10, with the following new paragraph:

--Conventional cup type plating apparatus has not been so sufficient for these requests in more uniformly plating the whole target surface provided with fine wiring since the flowing condition of the plating solution constantly forms a flow spreading from the center towards the peripheral directions. Also there was limitation in uniformly plating larger area extending to peripheries of the plating target area of the wafers.--

Please replace the paragraph extending from page 5, line 12, to page 6, line 2, with the following new paragraph:

--The present invention was completed with such a background as described above, and provides a technology capable of plating wafers more homogeneously than before when plating them by using a cup type plating apparatus. Particularly, the present invention enables use of a diaphragm for the cup type plating apparatus without any problem of cost required for the diaphragm, provides a cup type plating apparatus that can respond to variation of the concentration of plating solutions to allow plating at stably maintained concentrations of the solutions, even when separate plating solutions are circulated in the anode side and wafer side separate chambers formed in a plating tank by separation with a diaphragm, and further provides a cup type plating apparatus that avoids nonuniformity at the periphery of the target surface of plating due to the flowing condition of the plating solution in a conventional cup type plating apparatus, and enables more homogeneous plating all over the target surface of plating.--

Please replace the paragraph extending from lines 3 to 13 on page 6 with the following new paragraph:

--In the present invention, in order to solve the aforementioned problems, a wafer is plated by supplying a plating solution through a solution supply tube provided at a

center bottom of a plating tank to the wafer placed at an opening at the top of a plating tank, while electrically connecting the anode provided in the plating tank and the wafer connected to the cathode, and in a cup type plating apparatus having a diaphragm for separating an anode and a wafer, a division wall having a plurality of openings covered with diaphragms is provided between an anode and a wafer so that they can be separated from each other.--

Please replace the paragraph extending from lines 14-19 on page 6 with the following new paragraph:

--This technology utilizes a division wall having a plurality of openings covered with diaphragms in place of the single diaphragm in the prior art. Therefore, the present invention can realize plating in good conditions using a diaphragm without technological and cost problems, because a diaphragm of large area is not required.--

Please replace the paragraph extending from lines 4 to 26 on page 7 with the following new paragraph.

--Here it is possible and preferable that the cup type plating apparatus according to the present invention is provided with non-conductive caps which are formed to fit in and detachable from the openings. When plating in a cup type plating apparatus, uneven plating may occur due to the property of the cathode to be connected to the wafer and nonuniform flow of the plating solution supplied as an upward flow. Of course it is possible in such cases to adjust the cathode or the flow of plating solution to reduce uneven plating, however such an operation is troublesome. Here, uneven plating will be avoided without troublesome procedures by using non-conductive caps capable of closing the openings provided in the division wall to be fixed in the optional ones of the

openings, since current density in the cross sectional direction of the plating tank can be varied at will. When a constitution with openings made at equal intervals on a plurality of circles concentric with the liquid-supply tube receptacle is adopted, uneven plating will be further avoided, since not only uniform current density becomes easily obtainable, but also variation of current density at every part becomes easily calculable, and as a result optional variation of current density at every part becomes easily effected.--

Please replace the paragraph extending from page 8, line 23, to page 9, line 10, with the following new paragraph:

--The division wall explained above may be applied to a cup type plating apparatus as described above, namely any cup type plating apparatus in which a wafer is plated by supplying a plating solution through a solution-supply tube provided at the center bottom of the plating tank to the wafer placed at the opening at the top of a plating tank, while electrically connecting the anode provided in the plating tank and the wafer connected to the cathode. Thus, the division wall according to the present invention, formed to be able to separate an anode and a wafer from each other and having a plurality of openings covered with a diaphragm, is highly advantageous, because it can be used by adding to a conventional cup type plating apparatus without changing specifications of the plating tank, and therefore a simple cup type plating apparatus can be reformed to one utilizing a diaphragm.--

Please replace the paragraph extending from page 9, line 11, to page 10, line 7, with the following new paragraph:

--The present invention contemplates a solution to the problem of variation in the concentration of plating solution when a plating tank is provided with a diaphragm. Specifically, in a cup type plating apparatus in which a wafer is plated by supplying a plating solution through a solution-supply tube provided at the center bottom of the plating tank to the wafer placed at the opening at the top of a plating tank, while electrically connecting the anode provided in the plating tank and the wafer connected to the cathode, provided with a diaphragm in the plating tank to separate the anode and the wafer from each other and to form a wafer-side separate chamber and an anode-side separate chamber above and below the diaphragm respectively, and separately provided with a main plating solution circulation channel for charging plating solution to and discharging plating solution from the wafer-side separate chamber and an auxiliary plating solution circulating channel for charging plating solution to and discharging plating solution from the anode side separate chamber, a main plating solution reservoir for holding the plating solution of the main plating solution channel, an auxiliary plating solution reservoir for holding the plating solution of the auxiliary plating solution circulating channel, and means for mutually sending the plating solutions held in the main and the auxiliary plating solution reservoirs respectively are also provided.--

IN THE CLAIMS:

Please cancel claims 1-9 without prejudice to or disclaimer of the subject matter contained therein.

Please add new claim 10-11 as follows:

--10. A cup type plating apparatus, in which a wafer is plated by supplying plating solution through a liquid-supply tube provided at a bottom center of a plating tank to said wafer placed on an opening at a top of the plating tank while electrically connecting an anode and said wafer connected to a cathode provided in said plating tank, and a flow toward outside the plating tank from a liquid-flow channel is formed in the plating solution supplied in an upward flow from said liquid-supply tube and the plating solution is made contact with said target surface of plating of said placed wafer to complete plating,

wherein said plating apparatus is provided with a means for stirring beneath the target surface of plating of the placed wafer for forcibly stirring the plating solution supplied into the plating tank.

11. The cup type plating apparatus according to claim 10, wherein said means for stirring consists of a donut-shaped disc provided with stirring blades for forcibly altering the flow of plating solution around beneath the periphery of the target surface of plating, and a driving mechanism capable of holding said disc parallel to the target surface of plating and rotating perpendicularly to the upward flow of the plating solution supplied from the liquid-supply tube.--

REMARKS

Claims 10 and 11 are pending in this application. By this Amendment, claims 1-9 are canceled and new claims 10-11 are added. No new matter is contained in the amendments.

Please charge any fee deficiency or credit any overpayment to Deposit Account No. 01-2300.

Respectfully submitted,



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Attachments: Marked-Up Changes to Specification

MARKED UP CHANGES TO SPECIFICATION

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tank by separation with a diaphragm, and further provides a cup type plating apparatus that avoids nonuniformity [inuniformity] at the periphery of the target surface of plating due to the flowing condition of the plating solution in a conventional cup type plating apparatus, and enables more homogeneous plating all over the target surface of plating.--

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for holding the plating solution of the main plating solution channel, an auxiliary plating solution reservoir for holding the plating solution of the auxiliary plating solution circulating channel, and means for mutually sending the plating solutions held in the main and the auxiliary plating solution reservoirs respectively are also provided.--